THE MODERN FIRE DEPARTMENT.

---oOo---

A description of the organization, equipment and operation of the modern fire department.

by

Charles A. Whitney.

A thesis submitted to the Department of Mechanical Engineering and the Faculty of the Graduate School in partial fulfillment of the requirements for the degree of Mechanical Engineer.

1915.

Approved: _____.
Department of Mechanical Engineering.

THE MODERN FIRE DEPARTMENT.

---oOo---

A description of the organization, equipment and operation of the modern fire department.

by

Charles A. Whitney.

A Thesis

Presented to the University of Kansas, in fulfillment of the conditions for the degree of

Mechanical Engineer.

1915.

Bibliography.

Public Fire Departments.....Mr. Geo. W. Booth, Chief Engineer,
National Board of Fire Underwriters.

"Our Firemen".....A History of the New York Fire Department, Volunteer and Paid.
Augustine E. Costello.

Fire Prevention and Fire Protection.Joseph Kendall Freitag, B. S. C. E.

Hand Book of Fire Protection.....Everett U. Crosby
and
Henry A. Fiske.

THE MODERN FIRE DEPARTMENT.

INTRODUCTION.

ORGANIZATION.-Basis.
- Volunteer.
- Part paid and call
- Part paid and volunteer.
- Full paid.

Supervision.
- Direct by chief.
- Single Commissioner or Director.
- Board of Commissioners,
- Council Committee.

Enlistment and Promotion.
- By supervising body without requirements.
  - Influence of friendship, politics, etc.
- After examination under civil service.
  - Requirements.

Pension System.
- Support.
- Age limit.
- Other relief.
  - Continuation of salary

Companies.-Organization.
- Engine, ladder, hose, chemical, auxiliary squad, etc.

Officers.
- Chief and assistants.

Districts.

Membership.
- Company officers, engineers, privates.

Maintenance.
- Vacation, meal time. day off.
- Two platoon.

EQUIPMENT.
- Engines.
  - Steam.-reciprocating, rotary single and double acting.
  - Automobile.-reciprocating.-rotary, centrifugal.
- Ladder Trucks.
  - Aerial, city service, combination
- Hose wagons
- Water Tower
- Hose.-Standard Couplings.
- Chemicals.
- Minor Equipment.
  - On wagons and trucks,
  - Heavy stream appliances.
- Fire Boats.

Repairs.-Shop, equipment.

Automobiles.

Fire Stations.

OPERATION.-Discipline.
- How enforced, supervising body, chief.

Response to Alarms.
- Number of companies.

Fire Methods.
- Use of chemicals.
- Size of nozzles used.
- Sprinkler connections.

Drills and Training.
- Drill Tower
  - Equipment.
  - Classes.
- Company Drills.
- Engine Operation.

Building Inspections.

Reports and Records.
- Company Journal
- Captain's report to chief.
- Chief's Records.
- Monthly and annual reports.
- Apparatus and Equipment Record.

THE MODERN FIRE DEPARTMENT.

When our forefathers came to America in the Fifteenth Century they found a country thickly covered with forest, the timber from which gave them ample material for their simple dwellings. In the course of time as the settlements grew from the few scattered houses to more closely built villages, the settlers found it necessary to take some measure to prevent the spread of fire. The material used in construction being of a very inflammable nature, and in many cases the chimneys themselves being of wood chinked with mud, extra precautions had to be taken to see that no unnecessary ashes and sparks collected in them, the fuel used being very prone to fill the chimneys with fine ashes and emit large volumes of sparks. The first record which we find of the passage of a fire prevention act was in 1648 when the householders were required to keep their chimneys clean or to pay a heavy fine and a still heavier fine was imposed in case a fire actually occurred. In addition they were required to keep a certain number of fire pails, the number being based on the number of chimneys. It was not long until, in the large colonies like New York and Boston the fire pails were found to be an insufficient protection against the spread of fire. About the year 1731 the first hand engine or "tub" as it is more commonly known was introduced from England and companies were organized to operate them. From these first hand engine companies grew what in later years became the strong social and political organizations, which even today exist in several of the eastern cities, for instance, Reading, Harrisburg, and Allentown, Pennsylvania and Wilmington, Delaware. These organizations can through their influence control a city election. For example, early in 1914 the City Council of Reading passed an ordinance to establish a full paid fire department; this ordinance came up for a referendum vote of the citizens

and through the influence which the volunteers had the ordinance was defeated. The first of the hand engine companies received a nominal sal salary from the city, but in later years with the introduction of steam fire engines and the construction of water supply systems, volunteer companies were organized, which in their turn have or are rapidly giving place to the full paid department.

The organization of the modern fire department divides itsely into four divisions: First, the volunteer, which is a survival of the early organization, when the municipalities were small and the citizens depended upon each other for mutual protection. In the better known volunteer departments, specially in the eastern part of the United States, the different companies partake very much of the nature of a social organization and their houses are maintained as club houses, with all the demoralizing influences incident to such an organization. In Allentown, Pennsylvania, for instance, the houses being the property of the city, intoxicating liquors are not allowed on the premises, yet most of the companies maintain an annex, on private property adjoining the fire station, which in some cases is even connected with the station itself. The chief of this department volunteered the information that if he could close the club rooms he could eliminate practically all the infractions of rules by members of the department. Intoxicating liquors of all kinds may be obtained in these annexes. The pleasures offered by the club houses and the annual "muster" or exhibition are not such as would attract many fire fighters and the pleasures offered do not develop an efficient fire fighting force. At the annual exhibition or at the district convention a company sometimes takes its apparatus to a neighboring city for an exhibition and parade, leaving part of their own city without the normal protection. Nevertheless, the volunteer fireman has done and is still doing a great work in protecting his home city from

fire. For, without him many a small city and village would be entirely without protection and every credit should be given to the man who risks his life for the sake of his neighbors. The one great drawback to the system in many small municipalities is the lack of encouragement from those in authority. The small organization wields no influence and being of no use to the politician gains no consideration from the latter.

Second, there is the part paid volunteer department, or volunteer with paid drivers. This is but little better than the volunteer. The full paid members seldom exceed in number more than one for each piece of apparatus in service and there are three periods during the day when the men are at meals that there is no one on duty, and as has been found frequently the house is locked so that in case of an alarm, even if a volunteer should reach the station before the regular driver, he could not get into the house.

The idea in having paid drivers on duty is that there is someone in the house to take the apparatus out and get it to the fire, picking up the other members on the way. Thus, it is not necessary for the volunteers to lose time by going to the house, but go directly to the fire. The greatest fault with this system, as with the volunteer, is that during cold weather and at night the apparatus reaches the fire without sufficient men to man it and there is a consequent delay in getting the fire under control. Then, when the men do arrive they are are in no condition to go into a smoke filled room, being out of breath from running. Since they do not receive training to fit them to fight fires and to take advantage of the opportunities offered they work at a disadvantage and know only that by pouring water into a burning building some of it at least will reach the fire and perchance check it. Another objection is, that frequently, the paid members are not under the direct control of the supervising body of the city government, but are responsible to the company for which they drive. The city makes a

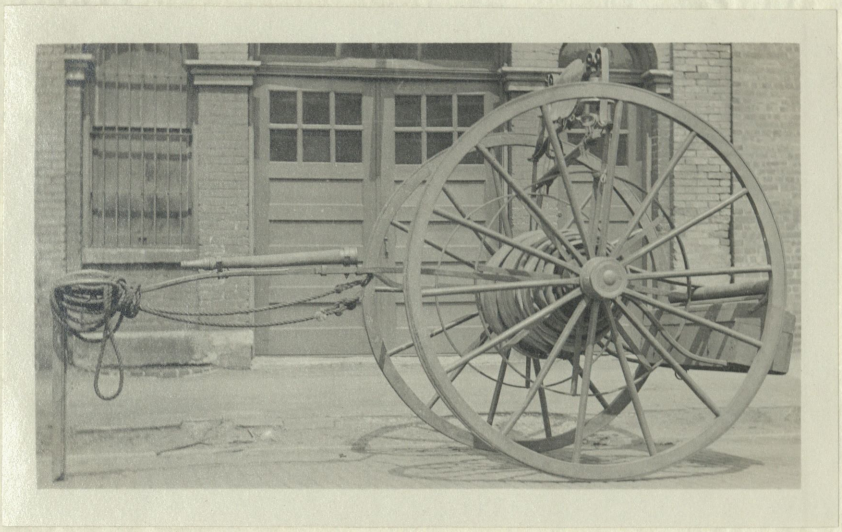
direct appropriation to the company to pay its running expenses, but leaves the selection and reprimanding of drivers in case of infraction of rules to the company. A third objection is that the chief officers are selected by vote of the members. The officials holding office by the suffrage of the members of the department are in no position to have their orders carried out or to enforce discipline if any member objects to his orders. At a fire in Allentown the chief had to beg and plead with the men to stay at the nozzles. Again, in order to help maintain the company the teams and drivers are frequently employed during the day sprinkling the streets or perhaps moving household goods and may be a considerable distance from their station at a critical time.

Third, there is the part paid and part call department. This is organized slightly different from either of the other two. First, there are the full paid members of each company which may consist of from one driver for each piece of apparatus up to any number of additional men, usually from one to eight and the call members. These latter are paid a nominal amount, either by the year or for actual time worked at fires, to attend alarms and assist the full paid men. To secure promptness in response the call men are usually fined for tardiness as well as absence. However, since the roll is not called until the company returns to quarters and as the captain is too busy at the fire to take note of members present, some return on the apparatus who have not seen the fire and answer to roll call. The great objection to this system is the delay of the call man in reaching the scene of the fire when he is most needed, which is the first ten or fifteen minutes, and when he does reach it, like the volunteer is no condition to go into smoke. To be of the greatest value in fighting a fire a man should arrive promptly and in condition to go into any kind of a building. In the case of a volunteer or call man his working clothes and boots may be on the wagon or truck or hanging in his locker in the station, where they are of the least value. That

man when he arrives at a fire is not going into a place where he is likely to ruin a good suit of clothes and probably remains a spectator. But when his company returns to quarters he is there to answer the roll call. The man who keeps his rubber boots and coat on the apparatus and is ready for work by the time he reaches the fire is the man who is of the most value to an efficient fire fighting force.

The full paid organization, is the fourth kind and the one that will be considered in the further discussion. In this system all members devote their entire time to the work and receive salaries accordingly. It is the most satisfactory, provided the minimum strength of companies is kept up to the least number of men that can operate the apparatus with which the company is equipped.

The methods of supervision are almost as varied as the systems of organization. For instance, a form seldom found,but one which is believed by some to be the best, is the plan by which the mayor or city council appoint a chief and make him entirely responsible for the operation and management of the department, with power to appoint or reprimand members as he sees fit and to the best interests of the service. Another form which is found in the larger cities is that of a single commissioner appointed by the mayor with power to appoint a number of deputies; New York, Boston, Philadelphia and Chicago. This commissioner receives a salary commensurate with the position and has full control over the department, appointing all men, making transfers and assignments, hearing trials of members up on charges of infraction of rules, purchasing supplies and apparatus. Then there is the board of three to five commissioners, one appointed each year by the mayor, usually non-salaried or receiving only a nominal salary and sometimes bi-partisan; Newark and Hoboken, New Jersey, and Holyoke, Massachusetts. A form which has developed along with the commission form of government is that of giving one of the commissioners supervision over the fire and police depart-



Early Forms of Fire Apparatus.

Hand Engine and Reel.
Engine built 1855.

ments and known as the director of public safety; Trenton, New Jersey, Allentown and Harrisburg, Pennsylvania, and Decatur, Illinois. A fourth form,which is sometimes being replaced by the last one mentioned is that of a committee from the city council or board of aldermen. As to which of these forms is the most satisfactory and accomplishes the best results is a matter of private opinion. In some cities one form will be a success while in another the same form will be an utter failure. No doubt the one form which is the farthest removed from political influences is the best for all purposes. The one that meets that condition to the greatest extent is the director of public safety in the commission form of government. The single commissioner appointed by the mayor, the board of commissioners, and the fire committee depending entirely as they do on the politicians for that particular position are easily controlled and obnoxious influences are introduced into the department, in the selection of members, in transfers, in discipline or lack of discipline and in the purchase of supplies. A number of men who have had an opportunity to observe believe the form which gives the best all round results, at least in the smaller cities, is the one in which the chief is given full control, but even this is subject to the same influences. The chief is usually a man of long experience as a fire fighter, is familiar with local conditions and in the small department knowing all his men personally is able to judge the kind of man required. The principal objection to this form of supervision in large cities is that the detail becomes too much for one man. As it is desirable to have trained men with long tenure of office in the department assured, some way must be devised to protect after they have once been appointed and this is best accomplished under civil service regulations. The power of appointment is likely to be abused where the supervision is in the hands of a single man who is subject to change at a change in the city administration. In this form friendship, politics, lodge and other influences exert a strong influence,

keeping the department in a more or less demoralized condition on account of the uncertain tenure of office. The executive officer has very little disciplinary power over the men on account of the same influences.

In states and cities where civil service is in effect the usual practice is to have a commission of 3 to 5 members, one appointed each year by the governor or mayor, in this way it is possible to have the least possible political influence. This commission has authority to draw up rules and regulations governing the physical and mental examinations, promotions, dismissals and transfers and has supervision over the examination of candidates for all positions in the civil list in addition to the fire department. To be effective for the fire department the civil service regulations should specify minimum and maximum age, height, weight and chest expansion for appointment. Before the mental examination the position for the commission conducts a physical examination, which eliminates many candidates. The mental examination, for privates is usually of a simple nature, covering simple problems in arithmetic, writing special reports and location of some of the more important buildings in the city and frequently location of fire alarm boxes. As men become candidates for promotion the examinations become more and more difficult and deal more and more with questions of an executive nature. Engineers of steam engines are frequently required to have a license from the boiler inspector or other supervising official and drivers of automobiles are required to obtain a chauffeur's license. In New York candidates for engineer are required to stoke and operate a steam fire engine maintaining prescribed steam and water pressures for about twenty minutes. For promotion men receive credit for experience, length of service and of late cities in New Jersey have started an efficiency record of members. To be eligible for promotion candidates are required to have held the next lower position for periods ranging from ten days to one year.

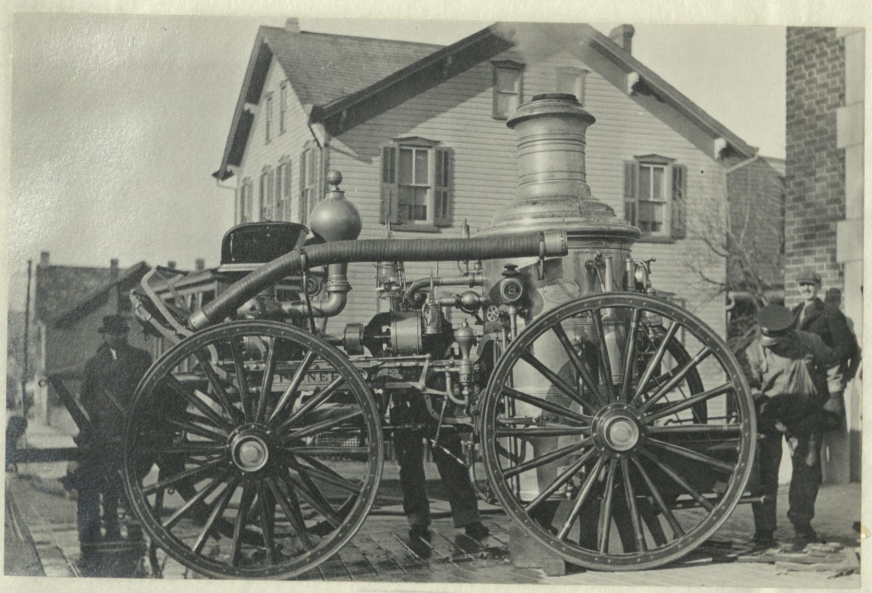
Even after a candidate has passed the civil service examinations, his appointment should not be mand permanent until he has served at least a six months probationary period and the officials have had an opportunity to observe his ability. Under civil service regulations members cannot be removed except for cause after trial before the supervising official or chief and may be represented by counsel and then they have right of appeal to the courts and the civil service commission.

The friends of civil service claim that under it politics are generally eliminated from the department, that a better class of men are obtained, discipline is better, men are more congenial and the men have an object towards which to look, since each man has an opportunity to fill any office in the department.

The opponents of civil service claim that the physical examinations are not such as to eliminate some men who are not fit for the fire service and that the mental examinations are such as to prevent otherwise good men from securing a place in the department. However, the opponents have not presented anything which produces better results than the present civil service regulations.

With tenure of office assured under civil service regulations, with possibility of promotion at any time after competitive examination, the next thing the fireman looks forward to is a suitable pension system so that he will have some income in case of accident and when he reaches the age at which he is no longer an efficient workman. The pension is arranged for in a number of ways. In some states it is supported by a small per cent. of the income of foreign fire insurance companies, and assessment on the salaries of the men, gifts, entertainments, etc. Some cities pay the pension direct from the fire department appropriation. The pension usually paid is one-half salary. The members of most departments maintain a local relief association supported by assessments and donations, which pays small accident and death benefits. The conditions

1.



2.

1. An engine built in 1862, single pump, double acting, 400 gallons capacity.
2. An engine built about 1875, rotary gear type engine and pump, 400 gallons rated capacity.

under which the pension becomes available vary, for instance, in case of total disability, after serving a specified time, after a long term of service if of certain age or on reaching a certain age if incapacitated. In New York City a man may retire after twenty years' service, in New Jersey in case of total disability or after twenty five years' service if fifty-five years of age. Few departments have a compulsory age limit for retirement, but many believe that all men should be retired on reaching the age of sixty-two years, unless they are at that time unusually active; this is the limit set in the United States army and navy, it is not an infrequent thing to find men from sixty-five to seventy-five years of age in departments, filling all positions from chief to the lowest private. With this exemption in force, a department may still avail itself of the long experience of the higher officials. Many cities continue salary to firemen in case of sickness or accident which is due to work at a fire.

The kind of companies to be found varies with the conditions in each city. Those usually found are, engine, hose, ladder, chemical, auxiliary squad and in the larger cities water tower, searchlight, rescue, fireboat and high pressure hose companies. Combinations of any two or three of these will also be found, as a combined engine and ladder or a combined hose, chemical and ladder. In some few cities there are also protective or salvage companies operated by the fire department. An engine company will consist of a steam engine and a hose wagon, if horse-drawn, but since the introduction of automobiles it may be only one piece of apparatus, i. e., a combined pumping engine and hose wagon. A hose company will be equipped with a hose wagon only; these companies are only practical where the water pressure is high enough to give an effective fire stream. The remaining companies are easily understood from their names. A description of the apparatus will appear in a later part of the discussion.

The number of officers will vary with the kind of organization and size of the city. The officers usually found, regardless of the kind of organization are chief, assistant chief, and a captain and lieutenant for each company. In a well organized and properly officered department there should be at least two chief officers for a small department and two officers for each company so as to have one on duty at all times. As the size of the city increases and the companies increase in number there should be about one additional chief officer for each additional eight companies.

To be an efficient officer requires a man of peculiar fitness and experience. He should first of all be a good executive, a good disciplinarian and be able to quickly size up a serious fire and plan his attack without delay, this latter can only be acquired after long service and experience in fighting fires in all classes of buildings and under all conditions.

The number of districts in a city will vary with local conditions, topography of the city, closely built districts, detached sections and the total number of companies plays important parts in finally deciding the number of districts. In the smaller cities covering a comparatively small area, the entire city will be included in one district, with the chief or his assistant responding to all alarms. As cities increase in size they are divided into districts with a chief officer in each. It is the usual practice to place from four to ten companies under the command of a district officer. Perhaps an important closely built manufacturing district with only four companies located within or nearby will be one district, while another will cover twice or three times the area and have ten companies within the bounds, but the values will be much less However, in laying out the districts great care should be taken to have them as near equal as possible so that the officer in command can reach any point without excessively long runs and will not have an excessive

number of companies.

The membership of companies will first of all include a captain and lieutenant as was mentioned above, and for engine companies an engineer and stoker, the latter to be sufficiently familiar with the engine so that he can operate it when the engineer is away. In addition to these four men there should be a total membership in any company to give the least number of men who can operate the apparatus when the company is at its minimum strength. For horsedrawn apparatus this will be at least six, better seven in congested districts for engine and ladder companies and five for hose companies, in residential districts this number may be decreased by two and when automobile apparatus is in service the company may be decreased by one. Where horse-drawn apparatus is in use, the drivers are not available until they make provision for the care of their horses.

The question naturally arises why is it necessary to make provision for the minimum strength of companies. In the ordinary walks of life this does not enter into consideration, but in the fire department the men are on duty for twenty-four hours and provision must be made for them to obtain their meals and an occasional day of rest and an annual vacation Practically all departments allow their men at least three hours a day in three periods, for meals. The meal period starts at six A. M., eleven A. M. and five P. M. and run three hours the men in each company taking their turn. The days off run from one in three to one in ten with an annual vacation of ten to fourteen days for privates and as high as thirty days for officers. The day off usually starts at eight A. M. and extends to the same hour of the following day. Some departments give an additional twelve hours off between the days off. In the New York department the men are given about forty-three per cent. of their time off. As an example of how this works out take a ten man company in a department in which the men are allowed one day off in five, there will

1.

2.

Automobile Combined Pumping Engine and Hose Wagon.

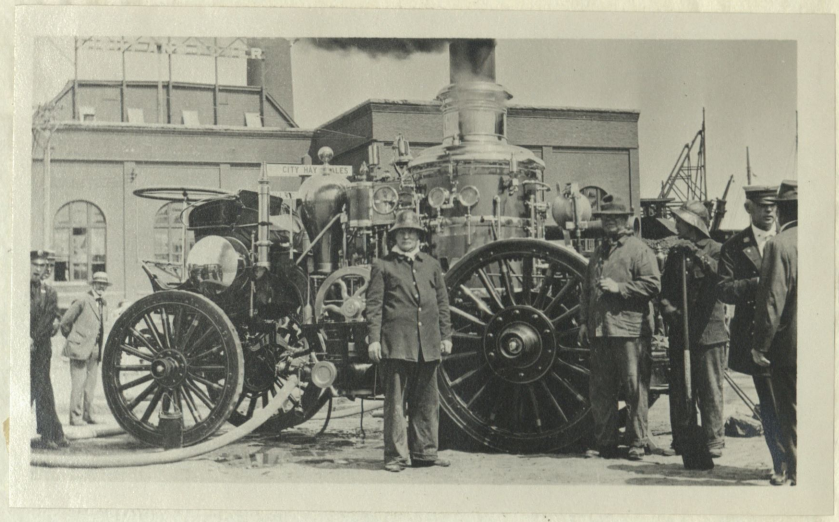
1. Triplex, single acting pump, $5\frac{3}{4}$-inch bore, 8-inch stroke, 750 gallons Six cylinder, 93.7 horsepower gasoline motor, hose capacity 1,000 feet $2\frac{1}{2}$-inch hose.
2. Rotary, gear type pump, 600 gallons capacity, 67.6 horsepower motor.

be two men on day off, one on vacation and two to meals leaving a total of five men on duty, hardly enough to operate an engine and hose wagon.

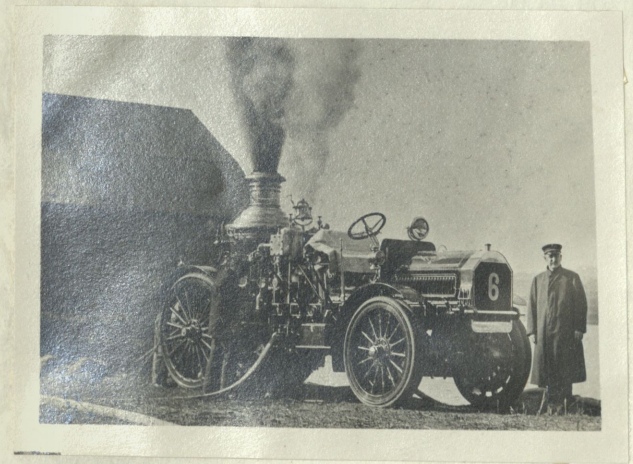
Some departments which are undermanned and in order to obtain all the men require them to respond to alarms during meal time and they cannot leave the city on their day off without permission from the chief, and when they do respond are given an extra day for the time which they have lost.

Along with the decrease in working time of all laboring men has come a desire to decrease the hours of the fireman, this is accomplished through the two platoon system. The arrangement in this system is to have two shifts, each serving twelve hours, or the equivalent, with the shift which is off duty available in an emergency. The serious objection to this system is the increased cost to the city, about forty per cent. more than the continuous duty system, decreased disciplinary control of the chief, the men do not report back on time on change of shift and lack of responsibility in care of apparatus. With the two platoon system each shift must be equal to the minimum strength of the companies and serve for the full ten to fourteen hours of the shift which they are on without opportunity of obtaining warm meals.

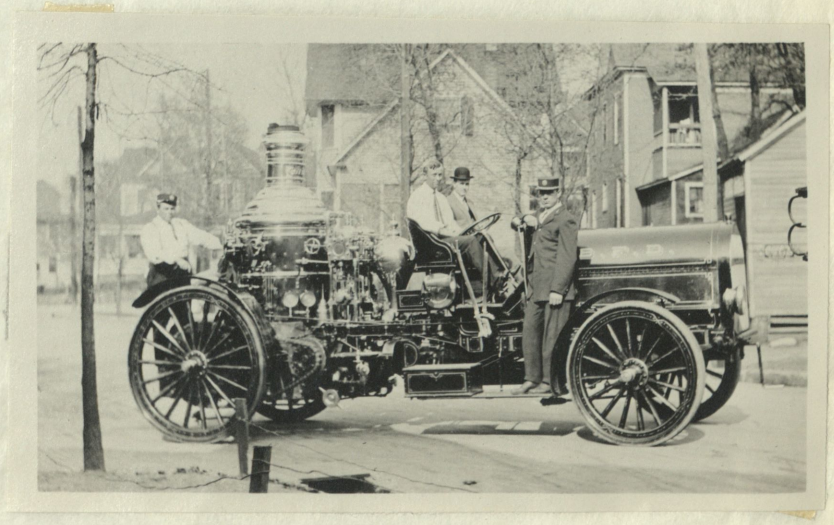
A properly manned and well organized department, however, can do but little effective work unless it is well equipped. Probably the most important and at least the best known piece of apparatus used by fire departments is the steam fire engine. This machine as used has followed somewhat the development of the stationary steam engine, up from the hand engine of the early days to the fairly efficient machine of today. The modern steam fire engine is an adaptation of a duplex, double-acting, crank and flywheel pumping engine, mounted with its boiler on wheels, the whole forming a complete unit. In its development the engine has gone through the various stages of single, double-acting long vertical stroke pump; horizontal, duplex, double-acting,



1.



2.



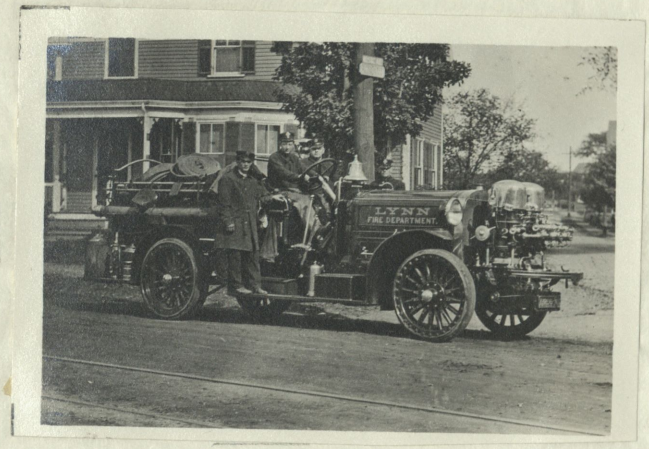
3.

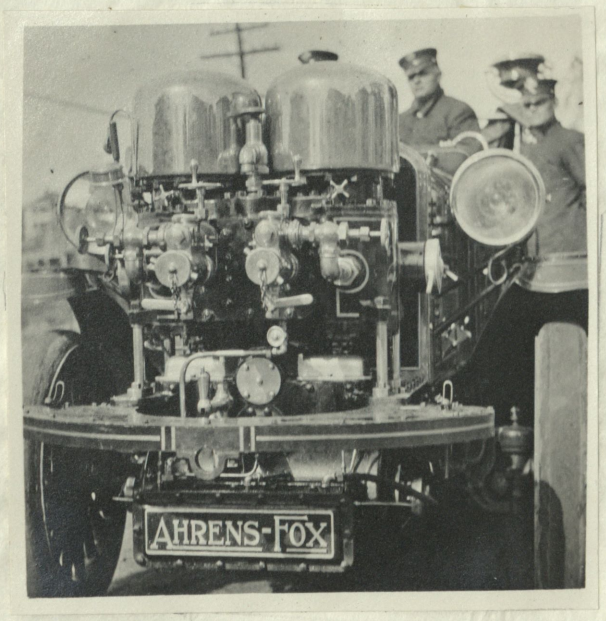
1. "Horseless" Steam Fire Engines.

1. Self-propelled, steam fire engine, 10000 gallon rated capacity, steam cylinders 9½-inches, pump 5¾-inches, stroke 8-inches. 2. Gasoline-electri automobile tractor, 3¼ horsepower electric motor on each front wheel, engine 900 gallons rated capacity, steam cylinder 9-inches, pump 5½-inches stroke 8-inches. 3. Automobile tractor, 650 gallon engine.

short stroke pump, without flywheel; and the rotary driven by a rotary steam engine. All these types have given way to the vertical, double-acting duplex engine with a stroke of seven to nine inches. The pumps vary in size from a diameter of three and five eights inches with a capacity of 400 gallons per minute to a diameter of six inches with a capacity of 1,100 gallons. This capacity is for a double pump, a few single pump engines have been built in the smaller sizes for places where a ligh machine was wanted on account of poor roads and heavy grades. The capacity is based on a piston speed of 400 feet per minute as the maximum fo steam engines. The boilers used on fire engines are of the quick steaming type with a small water capacity and large heating surface. The latest type boilers are of the coil or spiral tube type giving a large heating surface. In cities which depend all together on engines for heavy streams it is necessary that the engines be ready to go into service in the quickest possible time. This is impossible when the boiler is cold so heaters have been devised which are connected to the engine boilers through a slip joint and automatic valves. The water circulates through the heater and engine, keeping the tempefature at or near the boiling point. As the engine leaves the station in responding to an alarm the fire is lighted and usually by the time the fire is reached the engine safety valve is blowing off.

From the early days of the steam fire engine it has been the wish of fire departments and builders to do away with horses and have the engine self-propelling. The first attempt at this was to place sprocket wheels on either end of the crank shaft with heavy chains to the rear wheels. When pumping a key is removed which allows the crank to run free in the sprockets. The relief valve between the suction and discharge sides of the pump is left open while standing in the house and while propelling so as to give a free way for the water wgich is retained in the pump. The stearing is done through a rack and pinion on the front wheel gear very





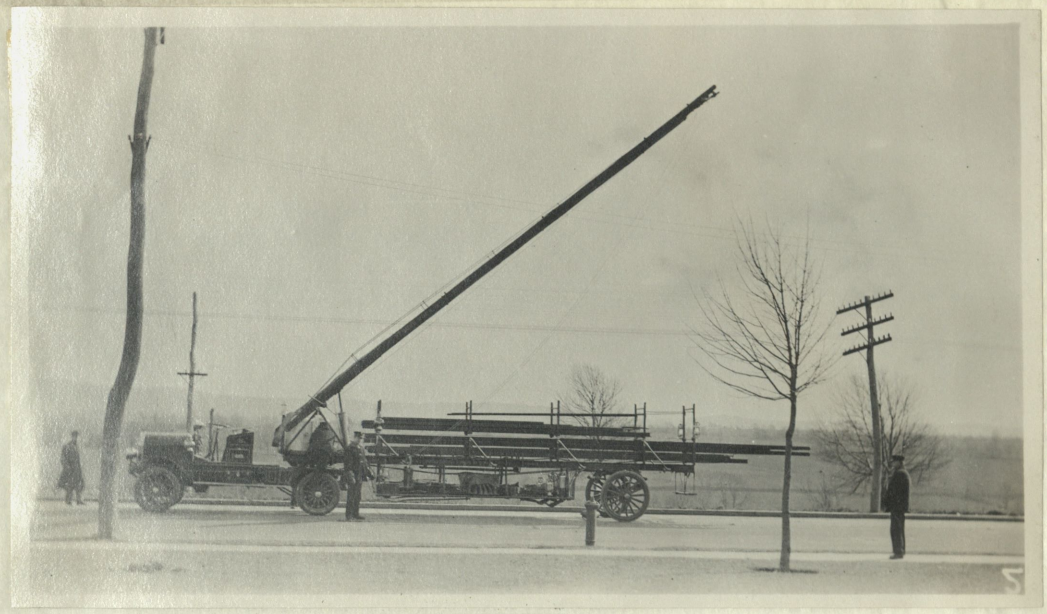
Automobile Combined Pump and Hose Wagon.
Pump placed on an extension of the side frames, in fron of the radiator. Six cylinder, 79 horsepower gasoline motor. Pump, duplex, double acting, diameter pump6½-inches, stroke 4-inches, rated capacity 700 gallons.

much as on an automobile. To have sufficient steam to propell these engines it is necessary to maintain about eighty pounds on the boiler continuously by means of a heater and to have a well alid fire so that there will be ample steam at once. The great draw back to this type of engine is the expense of maintaining steam and the great number of sparks emitted on the way to a fire.

The high powered automobile developed within the last few years is rapidly replacing the steam fire engine and horses for the heavy service of the fire department. The substituting of an automobile for a steam fire engine usually takes the place of two pieces of horse drawb equipment. That is the combined automobile pumping engine and hose wagon takes the place of a steam engine and a hose wagon and replaces four or five horses. It takes the well known form of the pleasure and commercial automobile with the motor in front under the hood, then the seat and hose body taking the place of the truck body of the commercial truck. The pumps on these machines are of a number of different type, the rotary cam or gear which are very similiar to an early type of steam fire engine, both single and double acting, multiple cylinder reciprocating and the centrifugal. The location of the pumps is almost as varied as the types, some are placed in front of the radiator on an extension of the side frames, some just back of the seat and some under the hose body over the rear axle.

The method of driving the rotary or centrifugal is very simple, since it is only a matter of reducing or increasing the speed of the motor through a set of gears, but with the reciprocating pump it is a more difficult matter. There the driving is done by silent chains or by worm gears from the transmission gear of the automobile.

Modern fire department practice has demonstrated that the most suitable size of engine for general use is the one which will deliver sufficient water for two good fire streams of about 250 gallons each.



Four Wheel Automobile Tractor as fitted to a ladder truck, formerly horse-drawn,, 45 horsepower gasoline motor. Aerial ladder raised by compressed air, air reservoir and lifting cylinders under lower end of ladder.

After allowing for inefficient operation, slip, and other conditions due to wear, this will call for an engine of about 700 gallons rated capacity. Except for village service, a municipality is hardly warranted in keeping in service an engine which will deliver less than 2 good streams. A steam engine of the double acting, duplex, reciprocating type to deliver 700 gallons per minute will require pumps 4-3/4 inches in diameter and to deliver 750 gallons per minute will require pumps 5 inches in diameter, this is assuming that the stroke is 8 inches. For use in the congested sections of the larger cities, engines of greater capacity are frequently used.

The National Board of Fire Underwriters recommends in its reports that: "That specifications for automobile combined pump and hose wagons to require pumps to deliver 700 gallons per minute at 120 pounds net water pressure. To have divided hose body with a capacity of 1,000 feet when carrying equal amounts of two and one-half and three inch hose. Motors to be capable of attaining a speed of thirty miles an hour, and of covering twenty miles in an hour over paved or macadamized streets having such grades as the apparatus is likely to encounter in service."

After the engine, probably the next most important piece of apparatus in the fire service is the ladder truck. Since, on it depends many times the saving of lives as well as affording the firemen a means of reaching the seat of the fire. The trucks, as used in a well organized department are of two types, the aerial, i. e., a truck provided with an extension ladder hinged at the base to a turntable on the main frame of the truck, over the front wheels and entirely self-supporting when raised in a vertical position. On account of the length of the two sections of the aerial ladder the truck has a very long wheel base. To provide means for turning and maneuvering in narrow streets, a tiller working on a rack and pinion is provided for the rear wheels. The second type is known as a servide truck and carries only ground extension

Automobile combination chemical and hose wagon. One 40-gallon chemical tank, small reel for 250-feet 1-inch chemical hose, hose body capacity of 1,200-feet of 2½-inch hose and 3 ladders.

ladders, the longest being an extension from forty-five to sixty feet when fully extended. Some of the older service trucks are provided with tillers on the rear wheels. Both kinds of trucks carry a number of shorter ladders down to roof ladders from ten to twelve feet long. The roof ladders are provided with folding hooks to catch over the peak of a roof. In order to reduce the weight of the ladders and make them easy for a few men to handle the modern ones are being made with truss sides instead of the old form of a single solid timber. There are several methods used for raising the aerial ladders, the earlier form was by a long screw manually operated, the next form was by heavy compressed spring which assisted in raising, the third form is where the ladder is raised entirely by springs and lowered by compressing the same. Air compressed to about 300 pounds and carried in a storage reservoir and acting on a piston, through a reducing valve, has also been employed; sufficient air is carried in the reservoir to raise the ladder about five times. Since the introduction of automobiles in the fire service, a number of trucks have been constructed in which the aerial is raised by electric motor which receives its current from a storage battery or from the generator of the gasoline-electric drive.

In departments making use of steam engines as well as those having hose companies, means must be provided to transport the hose to the scene of the fire. The hose wagon used today is the outgrowth of a great many years experience. It has passed through the various stages of two and four wheel hand reels, one-horse two wheel, one- and two-horse four wheel and automobile. The hose wagon has become almost a standard article of manufacture in its design and construction. The recommendation of the National Board of Fire Underwriters which are much used, say: "Automobile hose wagons to have divided hose bodies with a capacity of at least 1,000 feet of hose when carrying equal amounts of two and one-

1.

2.

1. Water tower in action, supplied by 4 lines of 2½-inch hose with water from a high-pressure water system, 2½-inch tips on both tower and turret pipe. 2. A manually raised, horse-drawn, aerial truck.

half and three inch hose. Motors to be capable of attaining a speed of thirty miles an hour, and of covering twenty miles in an hour over a paved or macadamized street having such grades as the apparatus is likely to encounter in service." The object of the divided hose body is to provide means for laying two hose lines simultaneously or the carrying of two sizes of hose. The latest type of wagons are also provided with a number of boxes for the carrying of equipment and running boards on the sides and rear for the men. Combination automobile apparatus is of frequent occurrance, consisting of a combination chemical and hose wagon, a combined pump and hose wagon or a combined chemical, pump and hose wagon, in each of these cases the hose body is the same, the chemical tank or pump being added as the case may be.

With the development of the steel frame building and the constantly increasing heights it became necessary to provide means from the exterior for the fighting of fires in the upper stories of a six, eight or ten story building. The water tower with the telescoping mast partially meets this requirement so far as it is possible to do with portable apparatus. The tower is a four or five inch pipe supported in a trussed framework hinged to a turntable much in the same manner as an aerial ladder and extending to a height of forty-five to sixty-five feet. In addition the tower is provided with a turret pipe on the deck, both pipes have from six to nine inlet connections and are provided with nozzle tips up to two and one-half inches in diameter. A water tower receiving a good supply of water at good pressure is a very effective extinguishing agent for any fire within the range of its height.

In cities and districts where it is not practicable or economical to install a water tower on account of the large investment involved a pipe is placed on the top of the stub of the aerial ladder of the ladder truck. This pipe is supplied through alline of two and one-half or three inch hose connected through a siamese at the bottom with two or more

lines of hose. The range of a ladder pipe is not so freat as a water to tower nor can it handle so great an amount of water.

Probably the one part of fire department equipment about which there has been the greatest amount of discussion and of which less is known outside of the manufacturers and others who have made a special study of it is the hose. No attempt will be made here to go into a complete description, but only a general statement of its composition and care will be given. The hose in fire service has a rubber lining about three-thirty-seconds of an inch thick with a woven or knit cotton jacket of from two to four plys. A good grade of hose is guaranteed by the makers to withstand a pressure of 400 pounds and to give at least three years service, but should give seven years service if well taken care of. The general practice in caring for hose when not used at fires is to shift it on the wagons every two to four weeks, to prevent the lining from cracking and the kacket from mildewing. After use at fires hose is generally uncoupled, rolled and thrown on the wagons, immediately on reaching quarters dry hose is placed on the wagon and the wet hose is washed and placed in the tower or rack to dry. When in service the cotton jacket picks up small particles of dirt and unless the hose is washed after being used these particles will work through the jacket and cut the lining. Refering again to the National Board recemmendations for hose, which are that each hose wagon be provided with a complete change of hose and that a spare hose wagons be provided and kept loaded with hose and stationed in or near congested districts. The spare hose is for use at large fires where additional hose is needed on account of the large number of engines and hose lines in service. The spacing of hydrants in most cities is such that after a first alarm the apparatus will be required to connect to hydrants at a considerable distance from the fire. At a recent large hotel fire considerable time was lost on account of the department not being provided with a spare wagon loaded

with hose. In order to place a deluge set in operation it was necessary for the service wagons to return to quarters for an additional supply, with a consequent delay. Reference has been made to three inch hose, the use of this size is strongly recommended as with it friction is much reduced, for instance with the standard fire stream of 250 gallons per minute a saving of about ten pounds for each 100 feet of three inch hose used over that for two and one-half inch hose. It is urged however, that the three inch hose be fitted with two and one-half inch couplings, the loss in friction through the two and one-half inch couplings on three inch h hose will not be appreciable. The three inch hose is more difficult to handle and is only used for outside leads from engine or hydrant to building and for lines to yurret pipes, water towers and other large stream appliances. The use of three inch hose is of special value in cities on a hydrant stream basis, since their water pressure is limited and they need to make use of every pound available for an effective stream.

A movement has been underway in this country for a number of years to standardize fire department hose couplings. The National Standard hose coupling was designed by a committee made up of representatives from several organizations, after considerable study and investigation. A number of departments have adopted the standard, but there are a great many more who have not done so. It is frequently found that cities very near each other which may require mutual assistance connot connect to each other. For instance one city in the east has hose couplings three and one-quarter inches over the male thread with six threads per inch, while the couplings in a nearby city are three and one-thirty-second inches over the male threads with six threads per inch and a large city a little farther away has snap couplings, a different type all together. The National Standard coupling for two and one-half inch hose is three and one-sixteenth inches over the male thread with seven and one-half threads per inch.

Of late years efficient fire fighters have been seeking means to extinguish fires with a minimum of water damage. The use of a stream from a two and one-half inch hose line in extinguishing an incipient fire means the release of a great deal more water than is actually necessary on account of the unwieldy hose and large nozzle. The use of water to extinguish a small fire in a residence or a store, unless a small hose and nozzle is used, means considerable more water damage than actual fire damage. To meet this condition the use of chemicals has come into almost general use. Everyone is famaliar with the common soda carbonate and sulphuric acid extinguisher, which is operated by simply inverting. The carbonate of soda is dissolved in water and the acid held in a small glass bottle. Carbon dioxide gas is formed, which acting under pressure expells the water. In confined places the contained gas and soda in solution has some effect in extinguishing fires, but where there is a current of air, it is doubtful whether it is any better than so much water.For use in the fire department the portable extinguishers are made in sizes up to ten gallons, those for ordinary house service are of the three gallon size. To provide larger capacity, tanks of twenty-five to sixty gallons, sometimes in duplicate are provided on the different pieces of apparatus, chief's car, hose wagon, automobile pumping engine and ladder trucks. This combination as it is then called carries, permanently connected to the tank 100 to 250 feet of three-quarter or one inch hose on a reel or in a basket. The larger tanks are frequently provided with a connection for two and one-half inch hose for filling purposes and also that water may be used through the chemical hose after the chemicals have been exhausted. In the latter case the tank is bypassed and the water passes direct from the large to the small hose.

Until recently chemicals engines were of frequent occurance in fire departments, but they are being rapidly replaced by combination apparatus

1.

2.

3.

Heavy Stream Appliances.

1. Turret pipe as used on a hose wagon, in use at an engine test.
2. Deluge set with 2-inch tip, in use at an engine test.
3. Fire boat turret pipe.

on account of their very limited service. The horse drawn chemical engine consists of one or two tanks with a total capacity of between 120 and 150 gallons. A few automoaile chemical engines have been built with two fifty and one forty gallon chemical tanks, but as these machines cost practically as much as a combination chemical and hose wagon a city is hardly warrented in purchasing an expensive piece of apparatus which has such a limited use as a chemical engine.

The National Board of Fire Underwriters, recommend and experienced fire fighters have come to realize that fire apparatus must carry a good assortment of equipment in order for the firemen to perform their work efficiently. The equipment carried on hose wagons usually consists of shut-off nozzles with removable tips from five-eights to one and one-quarter inches in diameter,axes, an open nozzle, crowbar, improved door opener, bale hooks, hose straps, burst hose jacket, lanterns, siamese couplings, nozzle holders, short extension ladders, roof ladder and plaster hooks. The equipment carried on the ladder trucks is a more varied assortmentand in addition to that mentioned above includes, sledge hammers, shovels, brooms, forks, picks, wire cutters, battering ram, roof cutters, marine torches,wrecking hook, ladder dogs, cellar pipes, distributing nozzles, life net, smoke protector, surgical kit, and life gun. Since the experience of the New York department at the Equitable building fire, a number of departments are providing themselves with oxy-acetelene blow torches with which to quickly cut iron bars. The Lungmotor ot Pulmotor is also becoming common equipment to use in saving life. In addition to the above equipment are the heavy s stream appliances such as deluge sets, turret pipes, cellar pipes and siamese connections. A deluge set consists of about fifteen feet of three and one-half or four inch hose with a two to four way siamese for supply, a set of nozzles from one and one-quarter inches to two and one eighth inches in diameter, a holder and a platform to provided a convenient means of operating a stream from the ground or flat roof.

A small fire boat, 2 pumps 750 gallons rated capacity, steam fire engine type pumps, steam cylinders 8½-inches, pumps 5-inches, stroke 8-inches. Boiler 9-feet high, 74-inches diameter. Hull 71-feet long, beam 17-feet, draft 6.5-feet, speed 8 miles an hour.

The turret pipes are placed on the hose wagons or water tower and supplied by two or more inlets, nozzle tips up to two inches in diameter are provided. Several cities have constructed battery wagons which are equipped with several turret pipes, so that in case of a serious fire which is threatening to spread to adjoining buildings, several heavy streams may be brought into action at one point. The cellar pipes are jointed pipes by means of which a stream may be directed inot a smoke or fire filled room through a hole in the ceiling above and turned in any direction by the oparator.

In the above description, only the more important pieces of fire apparatus have been described, in addition the larger cities will often have other pieces such as searchlight engines or wagons, fire boats, coffee wagons, fuel and supply wagons rescue and salvage wagons. The searchlight engines are mounted on a frame similiar to that used for a steam fire engine with a quick steaming boiler, an electric generator driven by a rotary or reciprocating steam engine. It carries portable searchlights with long leads of flexible cable for use at large night fires. The searchlight wagons are automobiles carrying storage batteries and portable searchlights. The batteries and lights are arranged in units so that the whole may be easily transported from place to place and in an emergency the wagon used as an extra hose or supply wagon. The salvage wagons are what might be termed first sid apparatus, they are equipped with chemical tanks, waterproof covers and other devices found specially useful in the first few minutes of a fire. The water-covers are for spreading over the contents of rooms under that in which the fire is located and to protect as much as possible from water damage.

Many cities with a considerable water frontage have fire boats for the protection of the water front property. The hulls are similiar to tug boat design, equipped with quick steaming boilers and in the older boats with pumps much like those on steam fire engines, but of much

larger capacity, often up to 6,000 to 7,000 gallons per minute. Some of the more recent boats are equipped with centrifugal pumps driven either by a steam turbine or by electric motors from the main driving units. The boats are provided with a number of hose connections at convenient points and with at least one turret pipe. The larger boats have several turrets pipes, one on top of the pilot house, one on the after part of the deck house and sometimes one on a steel mast. Each boat carries a varied assortment of equipment found useful around the water front. Living accomodations are very limited on the boat as all the available space is taken up with pumps, boilers and storage space for equipment. Quarters for the boat company are provided in a station on the dock along which the boat is moored, convenient for the men to board. The use of the boats is not altoghether limited to water front fires. At Milwaukee, Wisconsin, for instance, pipe lines provided with hydrants at convenient intervals, extend sometimes for a mile back from the water. The inlet ends of these mains are provided with a six way siamese to which the boats connect through short lengths of three and one-half inch hose. Each inlet is provided with a check valve, so the boat may begin pumping as soon as one hose line is connected. Through a signal line which extends along the pipe line with a signal station station at each hydrant the official in charge of the fire may notify the engineers on the boat when to begin pumping and the pressure desired. Wagons carrying large hose and nozzles meet the boats at the inlet ends of these pipe lines and carry the men to the scene of the fire and when more large hose is required return to the boat for it.

A recent addition to the New York department is an automobile carrying appliances found specially useful in life saving.

An important consideration for any department is the method and rapidity of making repairs to apparatus for ordinary wear and in case of accident. With the introduction of automobiles and the closer attention

required by them, it is worth while for many departments to install a repair shop with a few machine tools and the ordinary hand tools. With such a shop practically all the repairs may be made by members of the department, much quicker and by men famaliar with the apparatus, than by those in a commercial shop. With one responsible man in charge of the shop to direct, sufficient mechanics may be found among the other members to assist him. Of course as the department increases in size it becomes necessary to maintain a regular shop force with special mechanics in all lines. Some of the repair shops in the larger cities are equipped to bu build complete apparatus. The Milwaukee shop formerly built all the horse drawn wagons and a number of the ladder trucks. For the ordinary department shop a lathe with a swing of about eight inches and an eight foot bed, a drill press, a shaper, forge, grinding machine and hand tools will be ample equipment.

Mention has been made of the introduction of the automobile into the fire department, with the general knowledge of the introduction of the automobile to all uses, it is hardly necessary to go into ~~xxxxx~~ complete description of it. Many of the hose wagons and some of the other apparatu are rebuilt commercial trucks or even touring car chassis. On account of the heavy service the specially built fire apparatus is of much heavier construction than the commercial truck. Some advantages of the automobile over horses for the fire service are, first: economy. many times a combined automobile pump and hose wagon, taking the place of two pieces of apparatus will replace four or five horses; three horses are frequently used on a steam fire engine. It is claimed that the money saved in maintenance of horses will pay for automobiles in seventeen to twently years. Second, increased speed of response and making it possible to catch the incipient fire before it has had an opportunity to spread. Third, replacing horses with automobiles, practically increases the stre strength of the department by one man for each automobile, as the driver is available for duty at once, without waiting for him to secure

his horses.

In an affort to convert good horse drawn apparatus into automobiles, a number of tractors have been designed, There are several different types of these, two, three and four wheeled. Straight gasoline drive, gasoline-electric and electric drive from storage batteries. The three and four wheel tractors are applied to steam fire engines and ladder trucks in place of the front wheel gear.. This type of tractor may be removed at any time and the original horse drawn gear replaced, i. e. it does not involve any structural changes in the apparatus. The two wheel tractors being self contained and the wheels used for propelling a as well as for steering, are permanently fastened to the main frame of the engine or truck. Frequently structural changes are involved in applying the tractor.

The housing of the men enters to a great extent into the character, contentment and to a certain extent the discipline and efficiency of the men. It has often been observed that the appearance of the station will be reflected in the appearance of the men. First of all a station should be well arranged for quick response of men and apparatus, have good sleeping accomodations and good lavatory facalities. The earlier forms of stations had space on the ground floor for the hand drawn apparatus, with a meeting room for the volunteers either on the same floor or above. When horse drawn were introduced stalls were added and later as the departments were made full paid with men on duty permanently, the meeting rooms were changed to sleeping quarters. Many of these old stations are poorly adopted for a full paid department without extensive alterations. Where horses are used it is necessary to provide ample, well ventilated and well drained stalls. Since the introduction of automobiles many objectionable features have been removed from the houses, odors from the stable, the hazarduous storage of hay and grain and the space made available for other uses.

A number of houses recently constructed are of fire proof construction and have individual sleeping rooms for the emn. This later is a very good feature and a vast improvement over the old form of a common dorimotory. It offers more privacy for the men, improves sanitary arrangements and gives more opportunity for rest, since one restless man may keep a whole company awake. To meet conditions of fire service, there should be provided sliding poles from the second floor to the apparatus floor, wide exit doors and where horses are used means for automatically releasing them when an alarm is received and in a station housing a hose wagon either a well designed hose rack or a good tower. In locating fire stations care should be taken to locate them on main thoroughfares so that the company may quickly reach all sections of their district.

A well organized and equipped department is of little effect unless discipline is well enforced. To do this properly it should be of a semi-military nature and deference should bee shown to superior officers and be in the hands of the chief, subject to the approval of the supervising official in extreme cases. Discipline cannot be maintained if there is any political influence at work in the department, as any man reprimanded will go to his ward boss for protection. Neither can it be well maintained where the men are protected by civil service and the chief is not. In Massachusetts, for instance, all members below the chief are appointed under civil sefvice regulations, while any citizen may be appointed chief subject to removal at the pleasure of the appointing official.

Earlier in this discussionmention was made that the character of the city, topography and structural conditions would determine the number of companies required. These same conditions also determine the response to alarms. In ganaral at least two hose wagons should respond to all alarms in case both should be needed at once and to offset an accident which would prevent one from arriving. In the smaller cities one truck should

also respond to provide the necessary ladders, if the ladders on the hose are not of sufficient length for residential sections. As the values increase and the congestion grows the number of companies responding must of necessity increase. In cities where entire dependence is placed on engines for first streams there should be an engine for each hose wagon. The same response should be made to an alarm from a fire alarm box, telephone or any other means. A number of serious fires have developed because of insufficient response or of a delayed alarm.

To properly acquaint the men with the best methods of extinguishing fires and of methods of handling the equipment provided requires careful and constant practice. This is best accomplished through the drill schools which have been established in many departments. To secure the best results a drill tower is required. With a tower of sufficient height many actual fire conditions may be actually duplicated. The tower is usually of skeleton type with openings on one side corresponding to window openings and not less than sixty feet high. The equipment required on the tower should include all the important pieces carried on the apparatus, such as life nets, pompier ladders, life gun, life belts, siamese couplings and any mother special equipment. The drills include the use of ladders and proper manner of raising them, quick handling of hose, salvage work, life saving and use of all appliances. The classes are made up of one or two men detailed from the different companies and the course runs about two weeks, with two, two hour classes each day. In addition companies should drill with their apparatus frequently, coupling hose, raising ladders, operating engines, etc. The larger cities, such as New York, Boston and Chicago maintain drill schools which are operated practically the entire year and to which men from the departments in the smaller cities go for special training and then act as drill master in their own city.

To guarantee that the engines are in good operating condition they

should be operated frequently under fire conditions and to assure best results according to rules prepared by the National Board. At tests which engineers of the National Board make of the fire fighting facalities in different cities of this country, engines have been found which would not lift water or developed other serious defects. Engineers in fire departments frequently assert that their engines are in first class condition, but at times the engines of those who are the most positive have been found to be in the worst condition. These tests as run by the National Board are so designed as to develop the defects in engines, especially whe when the valves and pistons are in poor condition.

The efficiency of the fire department will to a great extent depend upon the methods employed in extinguishing fires. The aim of all firemen is to keep the fire losses for the year as low as possible and one way to accomplish this is to prevent water damage as much as possible. One of the methods to avoid this is by the extensive use of chemicals. In many departments the per cent. of fires extinguished with chemicals alone will run as high eighty per cent of the total. Then there is the use of water through small hose, use of shut-off nozzles, cleaning up after fire to prevent the water and chemicals used from leaking through into rooms not reached by the fire. There is also the use of waterproof covers to protec valuable property from water damage. At large fires which ahve gone beyond the chemical stage, just the opposite view is taken and large streams are used, and in fires which are approaching the conflagration point heavy stream appliances come into use. These are the deluge sets, turret pipes, water tpwers, ladder pipes and cellar pipes. On account of the great heat generated, it is only the large streams which will reach the center of the fire and accomplish the desired results. The small stream will tend to increase the fire by bringing oxygen into the flame. Many modern building are equipped with standpipes, in such cases the fire department can save

much time and friction loss by connecting their engines into the bottom of these pipes and carrying a section of hose to the roof or floor on which the fire is located than by raising a hose line the entire distance. The supply of water to automatic sprinklers may be greatly increased by th the fire department connecting to the outside connections and pumping dire ect into the sprinkler pipes. Where the sprinkler pipes are intact, this method will give much better distribution if water over the fire than the department could hope to secure with their nozzles.

The duties of the fire department do not cease however with the extinguishing of fires, it really only begins there. Their work is as much to prevent fires as anything else. This is accomplished through frequent and thorough building inspections. Many cities are giving their firemen authority to inspect buildings and to order the removal of hazarduous rubbish and other generally bad conditions. The building inspection accomplishes two results, removes hazards and thus eliminates many incipient fires and members of the department become acquainted with build ings and structural conditions. Where the department makes building inspections, it is the usual practice to detail men from the different companies and make a complete inspection of all business and factory build ings in the district about once to four times monthly. A few departments only ,ake inspections quarterly, but this is not often enough to accompli results.

Many departments fail to keep good records, such as records of fires, apparatus, hose and roster of men. One department visited kept fire records in pencil in a s,all pocket memorandum book, and were not sure of the total membership of the department, others keep a fire record only. To accomplish best results complete records should be kept, these to include a company journal, showing all happenings around each station, captain's daily and weekly report to the chief of fires attended, work

done, accidents to apparatus and men and supplies received. Then there are the chief's records of fires, which show location, occupants,and owners losses, kind of buildings, causes of fires and method of extinguishing. The chief should also make a monthly and annual report to the supervising officials of the condition of the department, roster of members and recommendations for improvements, In addition to these records and reports are the records of apparatus and hose which few departments outside of the larger cities keep. These records should preferably be on a card index system with a card for each piece of apparatusm showing the name of builder date purchased, date received, results of test, principal dimensions, equipment carried, dates and costs of repairs. The only practical way to keep records of hose is by placing a serial number on the couplings of each section as it is purchased and make an entry on a special sheet of the brand, cost, date of purchase, test pressure, annual tests, repairs and final disposition of each section.

In most of the average American cities the fire department is the last of the municipal departments to receive consideration from the finincial committee when improvements are being considered. The chief being the one on the ground and the one more famaliar with conditons, his recommendations should be considered, but usually the reply to him is that "you are taking care of the fires now, why cannot you do so a little longer, until the city is in a better finincial conditon" abd for this reason the chief should repeat his recommendations year after year if necessary, until they receive the kind of consideration they deserve.

Appendix No. 1.

In the recommendations with which the National Board of Fire Underwriters end a report on the fire fighting facilities of a city they always ask that complete records in a convenient form be kept of all fire department apparatus and equipment. In consultation with fire department officials in regard to keeping records, they frequently asked for a suggested form in which to keep records. To meet this demand and assist in securing the carrying out of the recommendations, the follwing forms were prepared after some study and work in gathering records from those departments which had suhh records. These offer a simple and convenient form. The cards as recommended are five by seven inches in size and suitable for use in any index file. Samples of these are left with the officials with the suggestion that this or some similiar form be used. A card is provided for each piece of apparatus. It will be noted that these cards may be used for either horse-drawn, motor-propelled or automobile apparatus.

(Face of Card)

Engine No.__

Make.-
Date Built.-
Date of Test.-
Boiler.-
  Type.-
  Make.-
  Diam.-
  Height.-
  Tubes.-
    No.-
    Diam.-

Engine.-
  Dia. Cyl's.-
  Stroke.-
  Dia. Pump.-
  Dia. Suction.-
  No. Gates.

Maker's No.
Date of Contract.-
Result of Test.-
Traction.-
  No. horses.-
Motor.-
  Kind.-
  Make.-
  No. cylinders.-
  Diam. " .-
  Stroke.-
  Horsepower.-
  Ignition system.-
  Self Starter.-
  Radiator.-
  Gasoline Cap'y.-

Lights.-

Capacity, Gals.-
Date Rec'd.-

Hose Capacity.-2½"
3".- Chemical.-

Chemical Tanks.-No.-

2½" Connection.-
Make.- Type.-

Tires.-Kind.-
Size.-

Weight.-On rear wheels.-
Total.-
Brake.- Axle.-
Ladders.-

(Revers Side)

Repairs.

Date	Nature of Job Cost	Date	Nature of Job	Cost	Equipment on Engine
					Automatic Relief valve. Churn valve, Fresh water connection. Steam)) Water) Gages Suction) Tipe on play pipes Dia.) Suctions Length) Suction strainer Steam hose Tools

(Face of Card)

Truck No. _____

Mkae.-
Date built.-
Date of test.-
Type.-
How raised.-
Traction
Motor
- No. horses.-
- Kind and Make.-
- Shop No.-
- No. Cylinders.-
- Diam. "
- Stroke
- Horsepower.-
- Self starter.-
- Ignition system.-
- Radiator.-
- Gasoline Cap'ty.-

Maker's No.-
Date of Contract.-
Result of test.-
Wheel base.-
Tread.-
Length over all.-
Width " " .-
Height.-" " .-
Tires.-Size.-
Axle.-
Weight.-Total.-
Chemical tanks.-No.-
Make and type.-
2½" connection.-
Ladder pipe.-
Ladders.-

Cosr.-
Date received.-

Kind.-

On driving wheels.-
Cap'cy.-

(Reverse Side)

Reapirs

Date	Nature of Job	Cost

Equipment on Ladder Truck

- Axes
- Bale hooks
- Buckets
- Burst hose jacket
- Cellar pipes
- tips..
- Cellar pipes, Sub.
- Chemical Extinguishers
- Chemical charges
- Deluge set
- Tips
- Forcible Entry tools
- Forks
- Gas key
- Hand pumps, Cap'cy
- Hose, Chemical.-
- 2½" 3"
- Hose roller
- Hose straps
- Hose shut off
- Hydrant gates
- Ladder pipe,
- Tips
- Lanterns
- Life-net
- Life belts
- Searchlight
- Megaphones
- Nozzles, Open
- Shutoff
- Distributing
- Nozzle holders
- Picks
- Plaster hooks
- Ram & Wall cutter
- Rope
- Rope gun
- Roof cutters
- Rubber gloves
- Siamese couplings
- Sledges
- Shovels
- Smoke masks
- Squeegees
- Surgical kit
- Tarpaulins
- Tools, Saws. Augers
- etc.
- Wall hook & chain
- Wire cutters

(Face of Card)

Hose Wagon No. ___

Make.-
Maker's No.-
Cost.-
Date built.-
Date of Contract.-
Date Rec'd.-
Date of Test.-
Result of Test.-
Traction
No. horses.-
Motor { Kind and Make.-
No. Cylinders.-
Diam. " .-
Stroke,-
Horsepower.-
Self starter.-
Ignition system.-
Radiator.-
Gasoline capacity.-
Chemical Tanks.-No.-
Cap'cy Gal.-
Make and Type.-
Wheel Base.-
Length over all.-
Width " " .-
Height " ".-
Tires.-Size.-
Kind.-
Axle.-
Weight.-Total.-
On rear wheels.-
Turret.-
Ladders.-
Hose Capacity.-3½".* 3".-
Body.-
Wood.-
Dovided.-
Chemical.-

(Reverse Side)

Repairs

Date	Nature of Job	Cost

Equipment on Hose Wagon

Axes
Bale Hooks
Brooms
Buckets
Burst hose jacket
Cellar pipes
Chain links, extra
Crow Claw bar
Door opener
Deluge set
Tips
Chemical charges
Forks
Hose roller
Hose shut off
Hydrant gate
Hose straps
Increasers
Lanterns
Life belts
Life net
Nozzles
Open
Shutoff
Revolving
Turret
Nozzle holders
Play pipes
Tips
Plaster hooks
Redusers
Rope
Rubber gloves
Searchlights
Small tools
Smoke masks
Sponges
Surgical kits
Tie straps
Wire cutters

Appendix No. 2.

The writer with an assistant made a test of an Ahrens steam engine and a Robinson automobile pumping engine to determine their condtion and the ability of the operating crews.

The Ahrens is a crank and fly wheel, double acting, duplex, vertical pump. The Robinson is an automobile with a six cylinder, 93.7 horsepower motor and a triplex, single acting pump, rated at 750 gallons per minute. The test on the Robinson was not very successful on account of valve troubles but is included here to show the need of frequent tests.

A small revolution counter was fastened to the frame of the engine and by a string to the eccentric of one engine and to the crank of the other. The velocity pressure at the nozzle was taken by a pitot gage. Knowing the discharge pressure at the nozzle and the size of the nozzle, the number of gallons discharged per minute is obtained from tables. These tables were originally prepared by Mr. John R. Freeman, after a series of tests and experiments with different nozzles. The tables were later corrected and extended.

To determine the condition of them boiler, the steaming time was taken from the time the fire was lighted until the safety valve popped. This was 16 minutes, indicating that the boiler is in fairly good condition.

This being a small engine and Of an old type, only one line was used. Attached to the other discharge gate was a calibrated gage, for the purpose of obtaining a check on the engine water gage. One 50-foot section of hose with a 1½-inch nozzle was first tried, but it was impossible to obtain the desired pressure of 100 pounds at the engine without over speeding, so the nozzle was reduced to 1¼-inches. With this the results given on the accompanying log sheet were obtained. The engine delivered an average of 339 gallon or 67.8 per cent. of its rated capacity against a net water pressure of 96 pounds, with a slip of 22 per cent. and an average

steam pressure of 100 pounds. During the 30 minute capacity run, one minute readings of water and steam pressuress and revolutions were taken an and 15 second readings of the nozzle pressure . After the capacity test, the steam pressure was reduced to below 70 pounds, then with both discharge gates, sprinkler, boiler feed, etc. closed, the churn (the relief valve between the suction and discharge sides of the pump)xxxx was opened and the engine started very slowly. With the engine running in this way the churn was gradually closed. When completly shut, the engine stopped with 130-pounds of water and 60 pounds of steam, indicating that under these conditions the pistons are tight. Supposing the pump leathers had been worn, then the engine would have continued turning, churning the water. If the slide valves are not properly set, the engine would run unevenly when the churn is partly closed. When the engine stopped, the throttle was closed and the steam chest drips opened. The water pressure dropped to 90 pounds and held, indicating that the discharge valves are tight at that pressure., and as no steam blew through the drips, the throttle was tight.

A test of the suction valves could not be made as there was no suction gage. This test is made when there is a gage on the engine or one can be connected to the suction cap. The caps are placed on both suction inlets and the water is discharged from the pump. then the engine is run until as much vacuum obtained as possible. Then the engine is stopped and if the valves hold this vacuum it indicates that they are tight.

The large slip of this pump is no doubt due to weak valve springs and worn valves not seating properly under the high speed.

The engineer of this steamer being sick. the stocker took his place and the firing was done by the engineer of another engine. The stoker was not experienced in heavy running and did not run up to full speed. At first he fed the boiler unevenly, but later under instructions of the observer and the engineer he improved and speeded the engine up slightly and fed his boiler more evenly.

The Robinson engine has been in service three years and under ordinary conditions should deliver its rated capacity. A hose layout and a nozzle to selected which would give this delivery with 120 pounds pressure at the engine. Two 100-foot hose lines were siamesed together into one 10-foot length of 2½-inch hose with a 1½-inch nozzle. With this arrangement could not raise pressure above 40-pounds and it was not until the nozzle had been decreased to 1¼-inches, one line closed entirely and the the other throttled, that the desired pressure was obtained. Under these conditions the engine delivered an average of 409 gallons for 9 minutes. The pump run very unevenly with a heavy vibration in the hose, so it was concluded that there was trouble of some kind in the pumps. The engine was taken out of service and the pump dismantled. One of the suction valve seats of the center pump had been blown entirely out of the deck plate. The valve seat, valve, bolt and follower were badly battered and worn, showing that they had been loose for some time and subject to pounding of the piston.

Under the usual fire conditions where only one or two lines of hose are taken from an engine, such a condition as exsisted here would not be discovered by the ordinary operator, specially where suction is taken from a hydrant. With a competent master mechanic in a department with authority to make frequent tests, this condition would be discovered and r remedied.

The test on the Ahrens engine indicates that it is in poor condition and only capable of delivering one fire streamand for that reason the city is not warranted in keeping the engine in service. It might do very well as a reserve engine to take the place of a larger engine in case of repairs or to use at a general alarm fire when all the pumping capacity is required.

Form No. 107—2000-8-'09.

NATIONAL BOARD OF FIRE UNDERWRITERS.

COMMITTEE ON FIRE PREVENTION.

LOG OF FIRE ENGINE TEST.

City Peoria, Ill. Engine No. Make Ahrens Builder's No. 364

Tested by C. A. W. H. V. M. Location Cistern Date 5-10-'15

Run by Reg. Stoker Fired by Engineer of Eng. 2 Coal Pittsburg Gas

AGE COMPARISON.

ENGINE: Size Type D'bl Recip. Rated Capacity 500 Built 1883

DIMENSIONS: Cylinders 6¾" Pump Bore 4 Stroke 8 Pump Rods 1-3/16

BOILER: Type Fox Diameter 32" Height 62" Built 1903

TEST GAGE No.	WATER GAGE.	NOZZLE PRESSURE. MIN.	¼	½	¾	TIME.	COUNTER.	R. P. M.	STEAM.	WATER.	#277 Eng. Suction. Gage	NOTES.
		41	42	38	39	4:55	76025		102	108		Steaming Time
		39	45	46	46		76276	blow	110	100		Fire lighted 11:35
		40	39	41	41		76525		90	72		20 lbs. @ 43
		43	46	48	50		76772		95	80		50 " @ 47
		52	52	51	47		77043	blow	118	98	108	1000 " @ 51
		44	42	39	37		77321		100	80		105 blew 51¼
		40	39	39	41		77602		70	77		
		44	48	50	48		77823		100	85		Tested at cistern
		47	47	48	50		78094		100	90	95	with 2' lift.
		51	50	48	47		78372	blow	105	98	100	One 60' line 2½"
		46	47	47	47		78643	"	105	98		C. R. L. hose with
		50	51	50	48		78927	"	104	98		1.285" nozzle
		47	48	49	51		79194		96	90	93	
		52	50	48	50		79475	blow	106	95	98	Firing good, eng-
		51	52	51	52		79758	"	105	100	103	ineer fairly good
		49	48	49	49		80045		99	90	93	considering his ex-
		52	49	47	47		80031	blow	105	93		perience in runnn
		53	54	58	57		80581		102	100		ing. Could have
		55	53	51	51		81826		100	105		speede up a little
		53	54	56	54		81019		98	100		more.
		55	53	53	44		81236		93	100		Fed boiler unevenly
		42	40	"	"	5:16						at first.

eam Gages
ont Rear
15
20
44

FIGURED BY H.vV.M

CHECKED BY C.A.W.

DISPLACEMENT TEST.

me	20
Ave. noz. pres.	48
Corrections	
Corrected pres.	48
Gallons per min.	339
Revs. per min.	361
Displacement	1.399
" (nominal)	1.663
Slip, per cent.	22%

CAPACITY TEST.

		Obsv'd	Corr'ctd
Duration, mins.	20		
Ave. r. p. m.	261		
Gallons per min.	339		
Ave. steam pres.		100	100
Ave. water pres.		93	92
Ave. suct. pres.		"	4
Net water pres.			96

HIGH PRESSURE TEST.

TIME.	COUNTER	R.P.M.	STEAM.	WATER.
Stuck			60	120

REMARKS.

VALVE TEST.

TIME.	WATER.
Dropped to 90 and held	

SUCTION TEST.

TIME.	SUCTION GAGE.
No gage.	

orm No. 107—2000-8-'09.

NATIONAL BOARD OF FIRE UNDERWRITERS.

COMMITTEE ON FIRE PREVENTION.

LOC OF FIRE ENGINE TEST.

City Peoria, Ill. Engine No. 4 Make Robinson Builder's No.

Tested by C. A. W. & H.V.M. Location Cistern Date 5-10-'15

Run by Reg. Operator Fired by One relief operator Coal Gasoline

GE COMPARISON.

ENGINE: Size Type Auto. Rated Capacity 750 Built 1912

DIMENSIONS: Cylinders Pump Bore 5¾" Stroke 8" Pump Rods

BOILER: Type Diameter Height Built

EST AGE O.	WATER GAGE.	NOZZLE PRESSURE. MIN.	¼	½	¾	TIME.	COUNTER.	R. P. M.	STEAM.	WATER.	SUCTION.	NOTES.
		72	71	69	72	3:22	2681			115		Tested at draft.
		71	71	72	72		2862			118		Two 100' lines to
		71	71	73	73		3091			115		10' of 2½" on siamese
		72	72	73	71		3311			118		Nozzle 1.285"
		72	72	70	70		3542			115		
		70	70	69	70		3773			115		Lift 38"
		70	69	68	70		4001			118		
		70	71	71	70		4224			115		
		71	70	70	70		4446			120		
		770	69	70	69		4671			118		
		709					4671			1167		
		71					(2681			116		
		638	637	639	638		9(1990			9(1051		
		637					221			117		
		639										
		638										
		36(2547										
		70.7										

Six cylinder 93.7 horsepower gasoline engine. Pump, triplex, single acting, driven by silent chain from the transmission.

FIGURED BY H.V.M.

CHECKED BY C.A.W.

DISPLACEMENT TEST.

)e	9
ve. noz. pres.	71
orrections	1
orrected pres.	70
allons per min.	409
evs. per min.	221
isplacement	1.85
" (nominal)	2,697
ip, per cent.	31

CAPACITY TEST.

Duration, mins.	9	
Ave. r. p. m.	223	
Gallons per min.	409	
	Obsv'd	Corr'ctd
Ave. steam pres.		
Ave. water pres.	117	115
Ave. suct. pres.		6
Net water pres.		121

HIGH PRESSURE TEST.

TIME.	COUNTER	R.P.M.	STEAM.	WATER.

REMARKS.

VALVE TEST.

TIME.	WATER.

SUCTION TEST.

TIME.	SUCTION GAGE.